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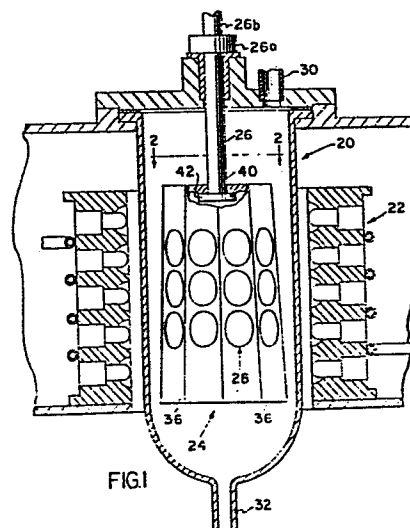
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54 **Susceptor assembly.**

57 A susceptor for holding substrates during a high temperature vapor deposition process is constructed from separable top, bottom and side plates interlocked to each other in a gravity maintained assembly.



SUSCEPTOR ASSEMBLY

The present invention is concerned with
susceptors of the type employed to support a plurality
of disc-like substrates or the like, typically silicon
discs or wafers, within a reactor during a high tem-
5 perature vapor deposition operation. This particular
process is well-known in the art, see, for example,
Rosler patent 3,796,182, and the McNeilly et al U. S.
patent 3,623,712 cited therein as disclosing a cool
10 wall radiation heated system.

To assist in achieving uniform deposition,
it is conventional practice to rotate the susceptor
during the deposition process and the susceptor is
therefore constructed to be symmetrical about a verti-
15 cal axis of rotation. Because the discs which the sus-
ceptor is to hold are flat, the conventional susceptor
configuration is of a polygonal transverse or horizon-
tal cross section with the respective sides inclined
inwardly toward the axis in their upward extent. Each
20 of the polygonal side surfaces is conventionally formed
with a plurality of circular pockets in which the discs

are placed. The susceptors are conventionally formed of graphite coated with a silicon carbide coating or another material which is opaque to radiant heat energy and absorbs the same to be heated thereby, for reasons well-known to those skilled in the art.

Today's typical susceptor is conventionally constructed as a one-piece or permanently assembled article. As noted in the above identified Rosler patent, it is much more convenient to load the discs to be treated onto the susceptor when the face upon which the discs are being loaded is in a horizontal position. Because the discs merely rest in their pockets, it is not possible with a one-piece or permanently assembled susceptor to dispose all of the side surfaces in a horizontal position during the loading operation. The solution to this problem proposed in the Rosler patent 3,796,182 is to construct each of the side surfaces of the susceptor in the form of a separate slab which can be loaded in a horizontal position and then hung onto a frame.

While the Rosler patent broadly teaches the advantages of constructing a susceptor with removable side walls, the structural arrangement proposed by Rosler has several disadvantages. As pointed out by Rosler, in addition to functioning as a holder for the discs, the susceptor itself absorbs heat from the

reactor and transmits this heat to the discs which it holds during the deposition process. In monitoring this process, heat sensors are located to sense the temperature of the susceptor slabs and modulate the heat radiation producing lamps accordingly. In order to obtain an accurate or undistorted reading from the heat sensors, it is necessary to shield the sensors from direct exposure to the susceptor surrounding radiant heating elements of the reactor. The individual slabs of the Rosler arrangement are widely spaced from each other which makes such shielding difficult.

In accordance with the present invention, a susceptor is constructed with separable top, bottom and side plates which interfit and interlock with each other when assembled to form an enclosed unit. It is a prime object of the invention to provide a susceptor unit which better resists high temperature warpage and so better retains the substrates and permits easy disassembly and reassembly. Another object of the invention is to provide an assembly which is made up of easily replaced sections.

Still another object of the invention is to provide an assembly which promotes the achievement of uniform temperature profiles to produce higher quality wafers and prevents radiation from reaching the interior of the susceptor enclosure.

Still a further object of the invention is to provide a susceptor which can be economically manufactured of expensive material without the waste which occurs when a one-piece cylindrical unit is produced and the core must be scrapped.

The invention may take the form of an assembly in which a top plate is suspended from the bottom of a vertical shaft and is formed with an upwardly opening groove in its upper surface spaced at a uniform distance inwardly from its periphery. Each side plate may be formed with a downwardly projecting flange offset inwardly from its inner side surface at the top of the side plate, the flange being adapted to be seated within a segment of the groove in the top plate. A generally similar, but upwardly projecting flange may extend along the inner side of each side plate at its bottom, and a bottom plate with a downwardly facing groove in its lower surface may be seated upon and cooperatively supported by the bottom flanges of the side walls.

The longitudinal side edges of the side plates are complementary and, when the side plates are all assembled to the top and bottom plates, the side edges of the adjacent plates are in flush face-to-face engagement with each other. In essence, the top plate of the assembly is suspended from a

shaft, the side plates are suspended from the top plate and the bottom plate is suspended from the side plates. The planes of the longitudinal side edges may be so oriented as to be non-radial to the central sus-
5 ceptor axis so that there is no direct linear path for which heat rays from external radiant heaters can reach the interior of the assembled susceptor, thereby shielding heat sensors located in the interior from direct exposure to the heaters.

10 Other objects and features of the invention will become apparent by reference to the following specification and to the drawings.

Figure 1 is a partial cross-sectional view, taken in a vertical plane, through a reactor showing
15 the susceptor of the present invention in place;

Figure 2 is a cross-sectional view taken on the line 2-2 of Figure 1;

Figure 3 is a perspective view of the susceptor of Figure 1, with certain parts broken away or
20 shown in section;

Figure 4 is a top plan view of the top plate of the susceptor;

Figure 5 is a side elevational view, partially in section, of the top plate;

25 Figure 6 is a bottom plan view of the bottom plate;

Figure 7 is a side elevational view, partially in cross section, of the bottom plate;

Figure 8 is a side elevational view of one of the side plates;

5 Figure 9 is a top plan view of the side plate;

Figure 10 is a detail cross-sectional view taken on the line 10-10 of Figure 9;

10 Figure 11 is a partial perspective view, in cross section, showing the details of the fit between a side plate and the top plate;

Figure 12 is a top plan view of a modified form of susceptor;

15 Figure 13 is a top plan view of the top plate of the susceptor of Figure 12; and

Figure 14 is a side elevational view of the top plate of Figure 13, partially in section.

20 In Figure 1 there is shown the general reactor environment in which the susceptors of the present invention are employed. An enclosed chamber 20 is surrounded by an annular array of radiant heating units designated generally 22, such as a surrounding bank of tungsten filament, quartz-iodine, high intensity lamps capable of producing high filament
25 temperatures in the range of 5000 to 6000°F. The lamps chosen typically are those capable of producing

maximum radiant heat energy in the short wave length range, preferably approximately one micron. The susceptor, designated generally 24, is suspended within chamber 20 from the lower end of a vertically disposed shaft 26. Shaft 26 is coupled as at 26a to a rotary drive means 26b, and may be driven in rotation at a relatively low speed.

The exterior surface of susceptor 24 is provided with a plurality of circular pockets such as 28 in which discs or wafers to be treated are seated, the discs simply resting within the pockets 28. Other types of supports for the substrates, whatever their shape, may also be utilized. Vapor which is to be deposited on the exposed surfaces of the discs is fed into the interior of chamber 20 through an inlet pipe 30 at its upper end and is withdrawn from an outlet pipe 32 at the lower end of the chamber. Chamber 20 is formed by a quartz jar, or the like, which is transparent to heat energy emanating from the lamps 22.

The present invention is directed specifically to the construction of the susceptor designated generally 24. Referring now particularly to Figures 3-10, it is seen that the susceptor is assembled (Figure 3) from a plurality of separable individual heat absorbing elements which include a top plate 34, a plurality of side plates 36 which, in the embodiment

of Figures 1-11, are of identical construction, and a bottom plate 38. Circumferentially spaced heat sensors are normally provided within the enclosure and connected with a control system for certain lamps 22 to maintain a constant temperature around the susceptor. If the operation of the sensors is distorted by the entrance of rays of heat the heat profile around the enclosure may be distorted and the quality of the wafers deleteriously affected.

10 In the embodiment of Figures 1-11, the top plate 34 is of a regular pentagonal configuration and is formed with a central bore, which, as best seen in Figure 2, is adapted to receive the shaft 26 of the reactor. As best seen in Figure 1, the shaft 26 is
15 formed with an enlarged boss 42 at its lower end, and to assemble top plate 34 upon shaft 26, a section 44 of the top plate is made separable, as by a tongue and groove sliding interfit 46 (see Figure 3) so that the section 44 may be completely withdrawn, the top plate
20 seated upon shaft 26 and then held in place by replacing section 44. Upwardly opening grooves 46 are formed in the upper surface of top plate 34 and extend parallel to each side edge of the top plate at uniform distances inwardly from the outer periphery of the
25 top plate.

Bottom plate 38 is of a configuration similar

to top plate 34. Downwardly opening grooves 48 are formed in the bottom surface of bottom plate 38 and extend parallel to each of the side edges of bottom plate 38 at uniform distances inwardly from the
5 respective side edges.

In the embodiment of Figures 1-11, each of the side plates 36 is of identical construction, as best shown in Figures 8-10. Each side plate is of one-piece construction and is formed of a silicon
10 carbide coated graphite, as are top plate 34 and bottom plate 38. Each side plate includes generally horizontally extending upper 50 and lower 52 webs which are interconnected by two angularly inclined side web sections 54, 56.

15 As best seen in the top plan view of Figure 9 (see also Figure 2) the inner side edges 58 and 60 of the respective upper and lower webs 50 and 52 are straight and are generally coextensive respectively with the sides of the top and bottom plates 34, 38.
20 The side surface sections 54, 56 are symmetrically and oppositely inclined relative to the inner side edges of the top and bottom webs so that when, see Figure 2, all of the side plates are in their final assembled position, an exterior side surface of a ten-
25 sided regular polygon is formed. As best seen in Figure 10, the outer side surfaces of sections 54 and

56 are inwardly and upwardly inclined. A plurality of circular pockets 62 are formed in the outer side of each of side sections 54 and 56.

5 A downwardly projecting flange 64 is formed along the inner side edge of upper web 50 and is con-
formed, as best seen in Figure 11, to be received within a groove 46 of top plate 34. A generally simi-
lar upwardly projecting flange 66 extends along each
inner side edge 60 of lower web 52 and is adapted to
10 be similarly received in the downwardly facing groove 48 of bottom plate 38.

The opposed longitudinal side edges of side plate 36 are formed in configurations complementary to each other as best seen in Figure 9. One longitudinal
15 side edge 68 is flat and extends at substantially right angles to the inner side edges 58, 60 of the upper and lower webs. The opposed side edge 70 is formed in the shape of an angular notch which is adapted to interfit with the edge 68 of an adjacent
20 side plate in a manner best seen in Figures 9 and 2. It will be noted that any radiation seeking to enter the interior of the susceptor between the edges of the side plates would have to follow an angular path. This is, of course, impossible and the linearly travel-
25 ing radiation is always reflected off and prevented from entering by this configuration. Further because

the side plates themselves are angular in plan section, they resist warpage at the extreme temperatures of the reactor far better than individual plates. Moreover, the angular configuration provides a better seal for denying entry of the heated reaction gases to the interior of the susceptor and prevents them from distorting the operation of the interior heat sensors.

The susceptor described above is assembled by first mounting top plate 34 upon shaft 26. The individual side plates are then loaded with discs (such as at D) to be treated and successively hung upon top plate 40 by engaging the flanges 64 in the respective grooves 46 in the manner best shown in Figure 11. After three adjacent side plates have been so assembled to top plate 34, bottom plate 38 is put in place, and the remaining two side plates are assembled by first hanging them from top plate 34 and then elevating the appropriate edge of bottom plate 38 slightly to permit the flange 66 of the side plate to be engaged within the corresponding groove 48 in the bottom plate 38. When completely assembled, the assembly, in effect, is maintained by gravity with the individual parts firmly interlocked with each other.

To remove a side plate 36, one side of bottom plate 38 is lifted to disengage flange 66 from

groove 48 and the lower end of the side plate is then swung outwardly slightly while the side plate is lifted to disengage flange 64 from groove 46. Then the side plate can be moved radially outwardly and placed on a table surface with the disc receiving pockets 62 disposed upwardly so that processed substrates can be removed therefrom and unprocessed discs substituted prior to reassembly.

In Figures 12-14 a slightly modified form of susceptor is disclosed which enables the construction of a susceptor of a regular polygonal configuration with an odd number of sides. The circumferential extent of each side surface section of the susceptor is largely determined by the diameter of the discs which are to be carried by the susceptor and in some cases an increased holding capacity may be achieved if the susceptor has an odd number of sides.

In the embodiment of Figures 12-14, the top plate 34' is of circular configuration and is formed with a continuous circular groove 46' spaced inwardly from and concentric with the periphery of the top plate. The bottom plate (not shown) of the Figure 12-14 embodiment is of construction substantially similar to the top plate of Figure 13. Side plates 36' of the Figure 12-14 embodiment are formed with inner side edges 58' of constant radius as viewed in plan and

have a downwardly projecting flange 64' conformed to be received within the notch 46' in generally the same fashion that the flange 64 of the Figure 1-11 embodiment was received in the groove 46 of the Figure 1-11 top plate. A similar arrangement is employed for the bottom plate of the Figure 12-14 embodiment. As was the case in the previously described embodiment, the longitudinal side edges 68', 70' of the side plates of the Figure 12-14 embodiment are complementary to each other and abut in face-to-face relationship, although in this case edges 68' and 70' are both completely flat and lie in respective planes which are not radial to the central axis of the assembled susceptor.

As best seen in Figure 12, the Figure 12-14 embodiment of the susceptor finds four like side plates 36' each having two angularly related side surface sections. The remaining side plate 136 is of an increased circumferential extent as compared to the side plate 36' so that it can have three angularly related side surface sections 136A, 136B and 136C, each of which is of the same dimensions as one of the two side surface sections on the other side plates 36'.

While two embodiments of the invention have been described in detail, it will be apparent to those skilled in the art that the disclosed embodiments may

be modified. Therefore, the foregoing description is to be considered exemplary rather than limiting, and the true scope of the invention is that defined in the following claims.

5 CLAIMS:

1. A susceptor assembly for supporting a plurality of disc-like substrates for high temperature vapor deposition, said assembly comprising geometrically similar top and bottom plates of graphite; means
10 for suspending said top plate in a horizontal position in symmetrical relationship to a central vertical axis, a plurality of vertically elongate graphite side plates, first means for suspending said side plates from said top plate around the outer periphery thereof, said side
15 plates each having a first longitudinal side edge and a second opposed longitudinal side edge of a configuration complementary to said first side edge such that when said side plates are all suspended from said top plate, the first side edge of each side plate is in
20 face-to-face contact with the second side edge of an adjacent side plate whereby said side plates define an enclosure about said central axis, means supporting said bottom plate within the interior of said enclosure, and means on each side plate for mounting a plurality
25 of substrates on the exterior side surface thereof.

2. The invention defined in claim 1 wherein the

exterior side surface of each of said side plates is defined by at least two intersecting longitudinally extending planar surfaces such that the horizontal cross sectional configuration of the exterior side surfaces is that of a regular polygon.

3. The invention defined in claim 2 wherein said first means comprises means defining a continuous upwardly opening groove in the upper surface of said top plate spaced a constant distance inwardly from the outer periphery of said top plate, and a downwardly projecting transversely extending flange on the inner side of each side plate adjacent the upper end thereof conformed to be received within said groove.

4. The invention defined in claim 3 wherein said means supporting the bottom plate comprises a continuous downwardly opening groove in the lower surface of said bottom plate spaced a constant distance inwardly from the periphery of said bottom plate, and an upwardly projecting transverse flange on the inner surface of each side plate conformed to be received in said groove in said bottom plate.

5. The invention defined in claim 4 wherein said top and bottom plates are of a regular polygonal configuration.

6. The invention defined in claim 4 wherein said top and bottom plates are of circular shape.

7. The invention defined in claim 6 wherein the exterior side surface of at least one of said side plates has three of said planar surfaces thereon, and the exterior side surfaces of the remaining side plates have but two of said planar surfaces thereon.

8. The invention defined in claim 1 wherein said longitudinal side edges of said side plates lie in respective planes which have oblique relationship to all planes containing said central axis.

9. The invention defined in claim 1 wherein one side edge of each side plate is formed as an angular notch from top to bottom to receive the other side edge of an adjacent side plate.

10. The invention of claim 1 in which each pair of abutting side edges lies substantially in a common plane which does not intersect the said axis.

11. In a radiant heated reactor for effecting a chemical vapor film deposition reaction on heated substrates positioned therein and heated thereby which includes

A. a radiant heat source, for producing and transmitting radiant heat energy,

B. means defining a reaction chamber, for receiving therein the substrates to be coated, adjacent said heat source and generally surrounded by the same, said chamber being

formed from a material which is transparent to radiant heat energy produced by said radiant heat source,

- 5 C. conduit means for introducing gaseous reactants into said reaction chamber and for withdrawing the spent reaction gases from said chamber, and
- 10 D. a susceptor assembly for supporting a plurality of disc-like substrates for high temperature vapor deposition, said assembly comprising: geometrically similar top and bottom plates of graphite means for suspending said top plate in a horizontal position in symmetrical relationship to a central vertical
- 15 axis, a plurality of vertically elongate discrete graphite side plates, first means for suspending said side plates from said top plate around the outer periphery thereof, there being means on each side plate for
- 20 mounting a plurality of substrate discs on the exterior side surface thereof, the improvement wherein said side plates each have a first longitudinal side edge and a second opposed longitudinal side edge of a configuration
- 25 complementary to said first side edge such that when said side plates are all

suspended from said top plate, the first side edge of each side plate is in face-to-face

with the second side edge of abutting contact with

an adjacent side plate whereby said side plates define an enclosure about said central axis, and second means is provided at the lower ends of said side plates cooperatively supporting said bottom plate within the interior of said annular enclosure.

- 10 12. A method of disassembling the side plate of a
susceptor assembly for supporting a plurality of disc-
like substrates for high temperature vapor deposition,
said assembly comprising geometrically similar top and
bottom plates of graphite; the top plate being sus-
15 pended in a generally horizontal position in symmetri-
cal relationship to a central vertical axis about which
it can be rotated, the top plate having an upwardly
opening groove in its top surface spaced inwardly from
its perimeter; a plurality of vertically elongate dis-
20 crete graphite side plates individually releasably sus-
pended from said top plate around the outer periphery
thereof, said side plates having horizontally inwardly
extending webs with downwardly projecting flanges
thereon releasably received in said groove, said side
25 plates also each comprising angularly disposed faces
and having a first longitudinal side edge and a second

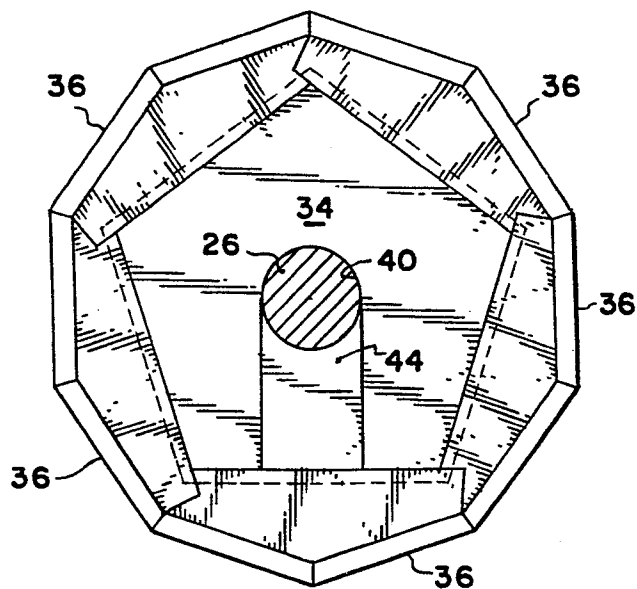
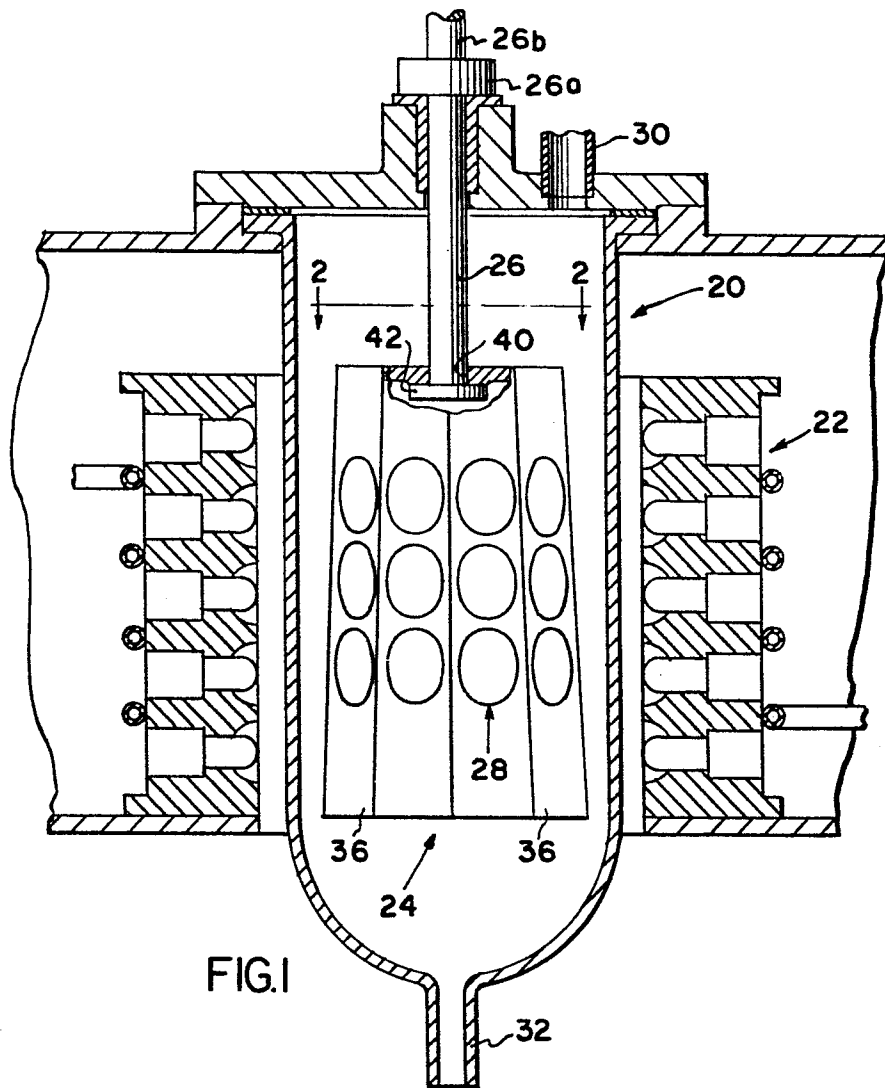
opposed longitudinal side edge of a configuration complementary to said first side edge such that, when said side plates are all suspended from said top plate, the first side edge of each side plate is in face-to-face contact with the second side edge of an adjacent side plate whereby said side plates define an enclosure about said central axis, the bottom plate having a downwardly opening groove in its lower surface spaced inwardly from its perimeter and the side plates having generally horizontally inwardly extending webs with upwardly projecting flanges thereon received in said groove to releasably cooperatively support said bottom plate within the interior of said annular enclosure, and each side plate mounting a plurality of substrate discs on the exterior side surface thereof; the steps of:

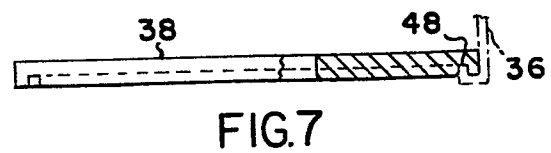
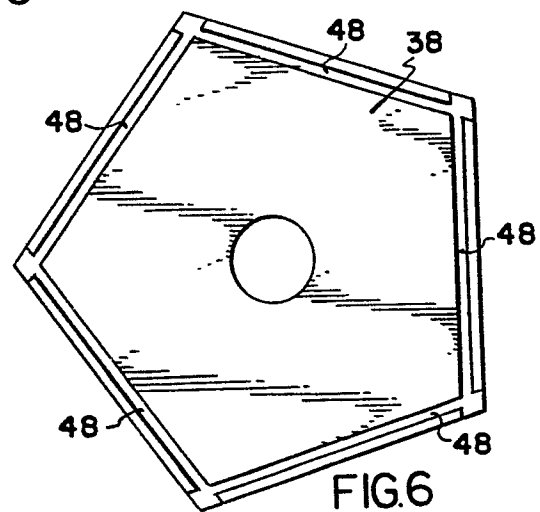
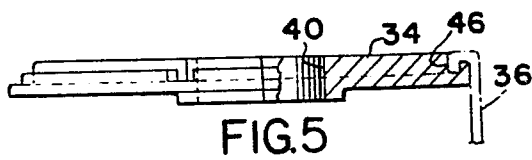
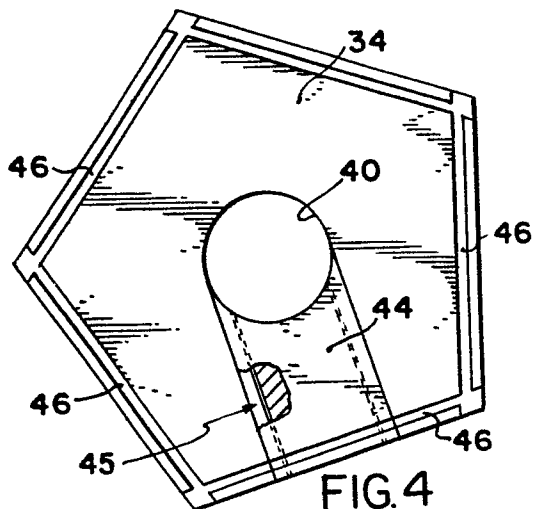
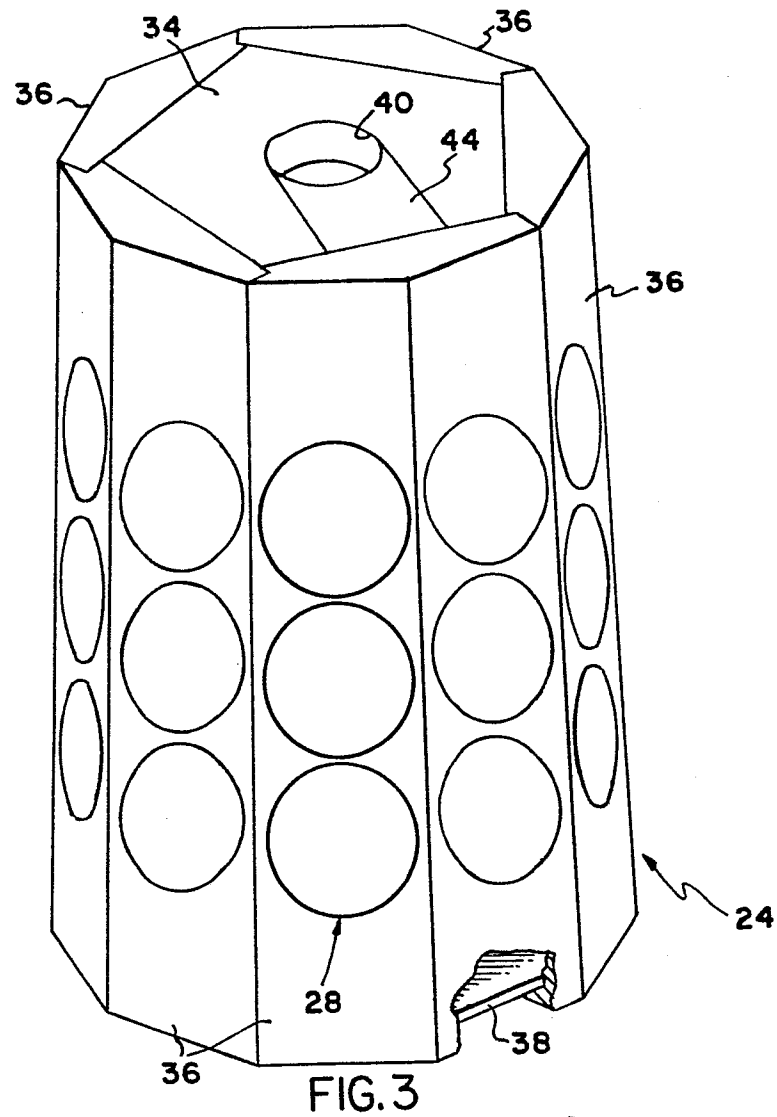
lifting the bottom plate at one side thereof to disengage the flange on the adjacent side plate from the groove;

raising the said side plate to lift the upper flange on the side plate from the groove in the top plate; and

removing the substrate discs from the side plate.

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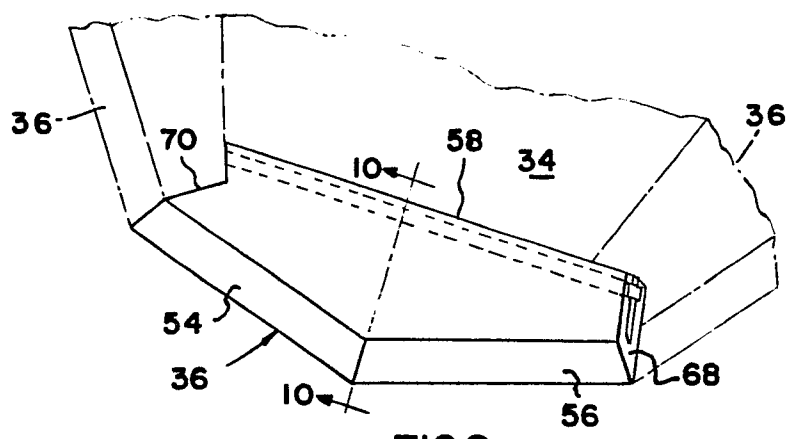


FIG. 9

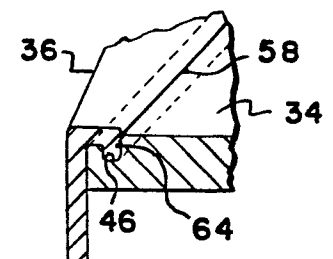


FIG. 11

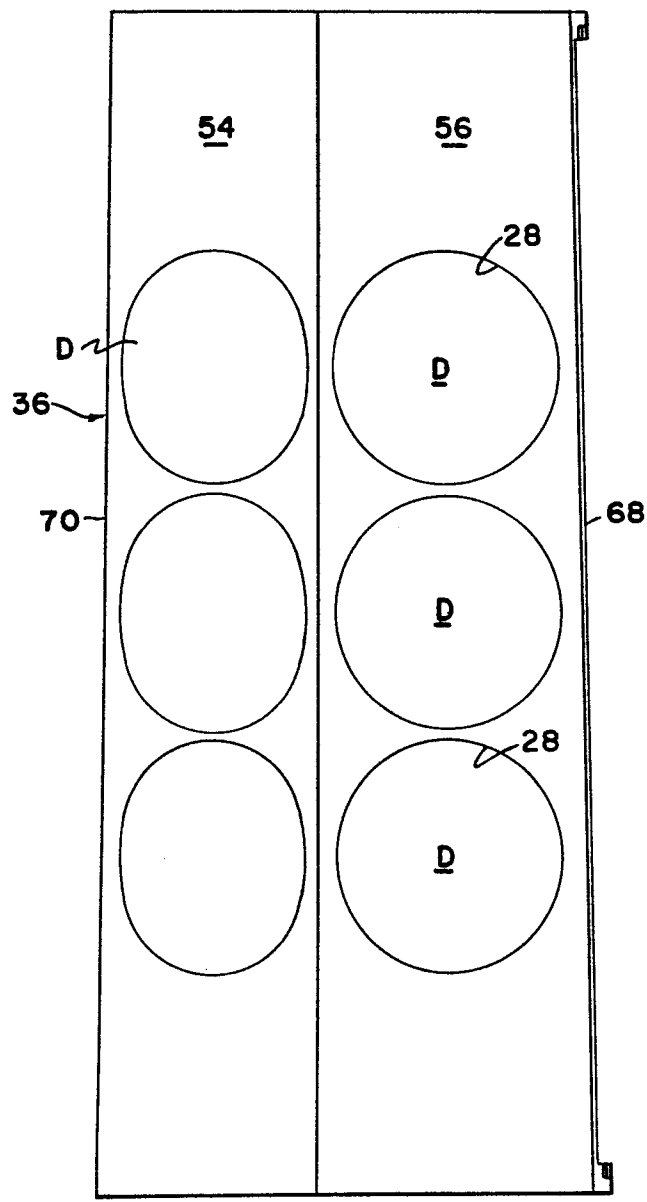


FIG. 8

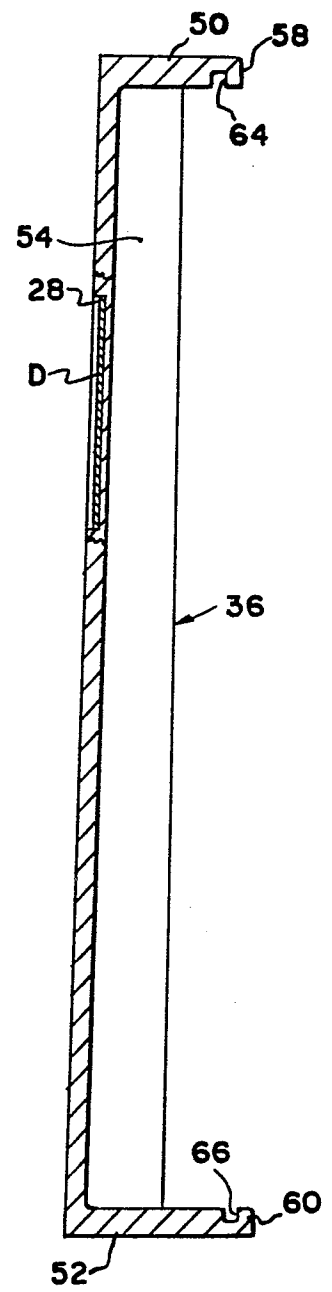


FIG. 10

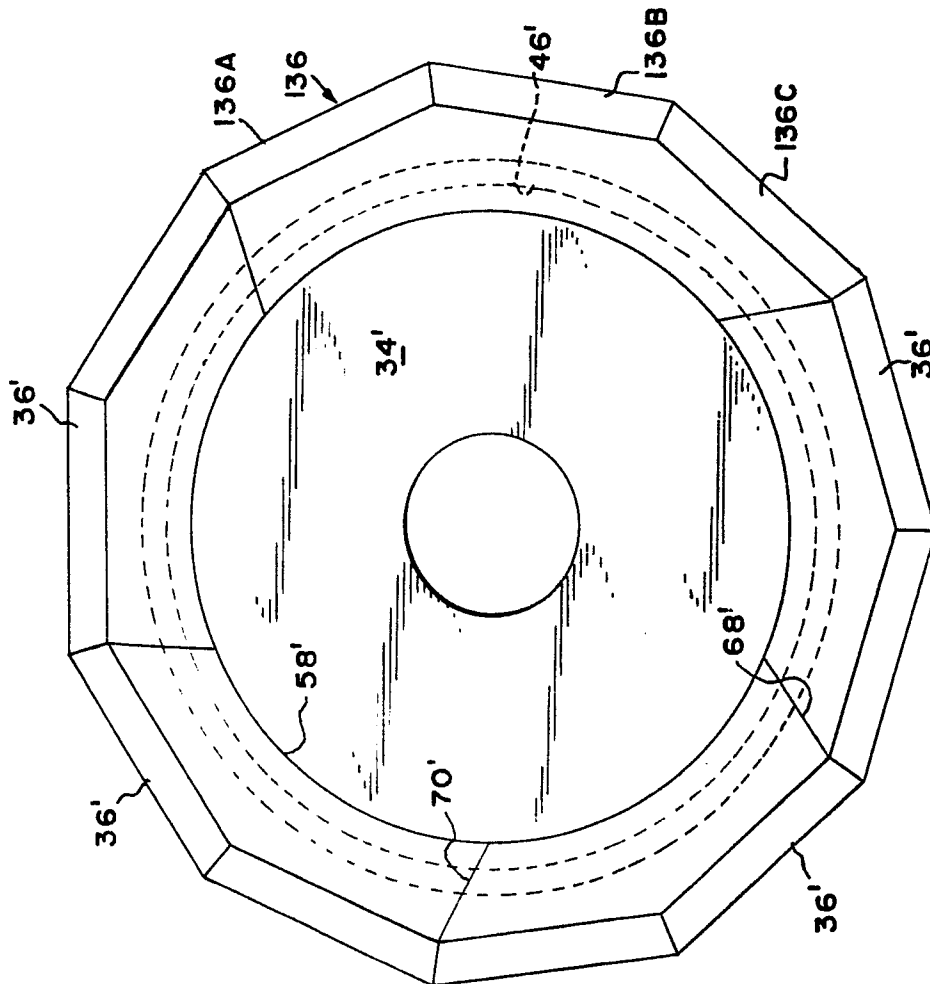


FIG. 12

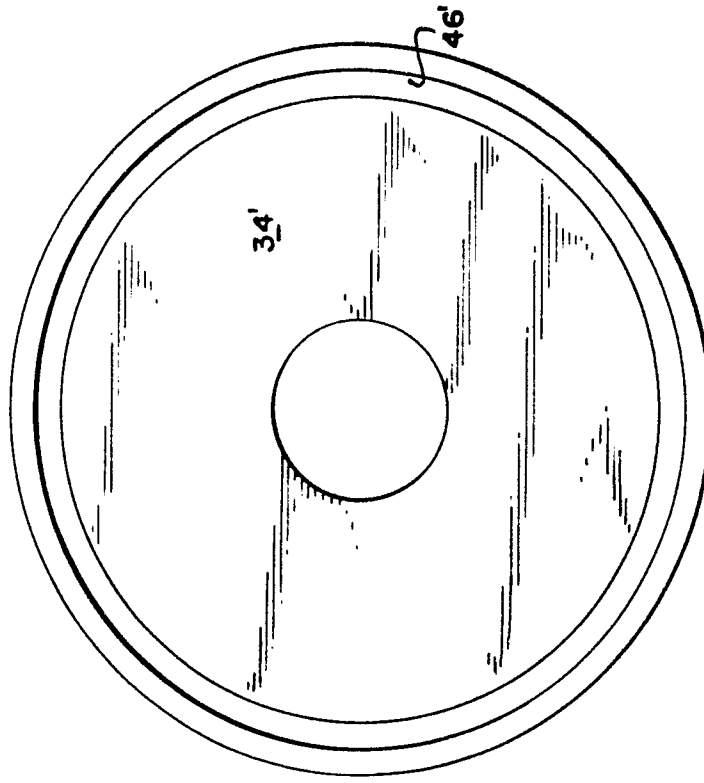


FIG. 13

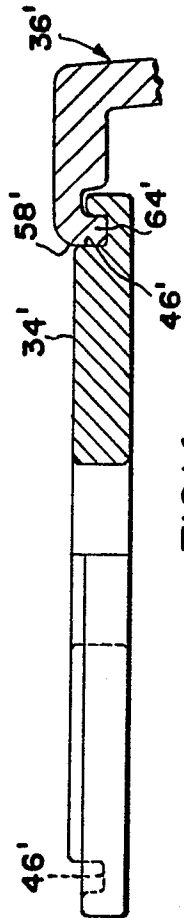


FIG. 14



European Patent
Office

EUROPEAN SEARCH REPORT

0131208

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 84107464.4
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. X 4)
X	US - A - 4 099 041 (S. BERKMANN et al.) * Fig., especially fig. 2, claims *	1-10	C 23 C 14/28 C 23 C 14/24
Y	* Fig., especially fig. 2, claims *	11	
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D,Y	US - A - 3 796 182 (R.S. ROSLER) * Fig. 1; claims *	11	

			TECHNICAL FIELDS SEARCHED (Int. Cl. X 4)
			C 23 C
The present search report has been drawn up for all claims			
Place of search VIENNA		Date of completion of the search 07-09-1984	Examiner SLAMA
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			